

## A PATTERN RECOGNITION STUDY OF COGGED STONE RITUAL BEHAVIOR

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*Cogged stones are magico-religious artifacts manufactured in the early Holocene Los Angeles basin. Within a ceremonial cogged stone cache, two cogged stones with identical counts of cogs constitutes a matched pair. Five matched pairs of cogged stones are identified and described for three cogged stone caches discovered at two sites, CA-ORA-950 in Lake Forest, Orange County, and the Rancho Los Cerritos Adobe site (LAN-696) in Long Beach, Los Angeles County. Statistical treatment of the data allows the inference that a selective process based on cog counts influenced the aggregation of each cache. The observed pattern may reflect a regionally shared iconography embracing dualistic symbology. Cogged stones are magico-religious artifacts (Koerper and Mason 1998) indigenous to the Los Angeles basin. Several types bear superficial resemblance to gear wheels of modern machinery, hence the name. Documented from early Holocene site components, the majority of these objects are circular and exhibit either vertically running elevations or, rarely, depressions circumferentially ringing the lateral surfaces of the artifacts. Observations of presence/absence of other design elements (e.g., small pits, depressions, holes, or concavities) on top and bottom surfaces further help to identify the range of varied likeness that establishes a unity of class. Some cogged stones are artistically fashioned, while others reflect less attention to symmetry and/or finish. A formal description of this class of artifacts and a set of taxonomic operations to identify the several types have been prepared (Underbrink and Koerper 2006).*

In local archaeology, scholarly attention directed toward cogged stones has long outpaced that accorded other material manifestations of regionally based magico-religious thought and behavior. An amalgam of historical, distributional, and aesthetic considerations coupled with uncertainties of past functions continues to stimulate scientific efforts to unravel the enigma of their meaning.

This report describes three cogged stone caches from two sites (Figure 1), focusing particularly on those observations that might reveal a symbolic program embedded within the cogged stone phenomenon. Judicious interpretations drawn on these observations, as well as considerations of ancillary data, are marshaled to gauge whether cogged stone iconography might possibly connect to some world-view thematic common to other sacred artifacts found within the southern California coastal zone.

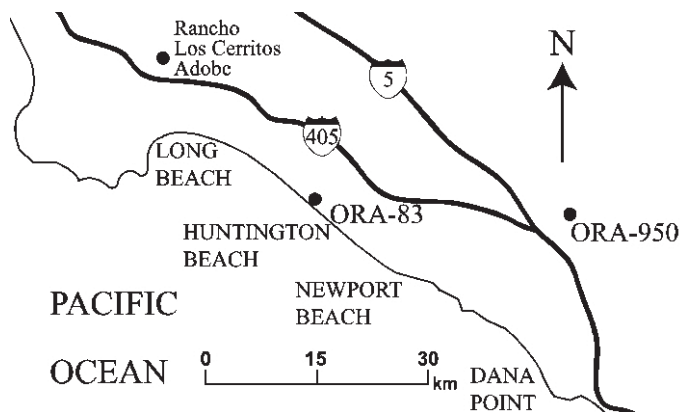
Preceding discussions of the cache evidence and interpretations of meanings, we first recount the functional conundrum and reject hypotheses attributing utilitarian employment to these artifacts. Background information is provided to track the spatial and temporal distribution of cogged stones.

### THE FUNCTIONAL CONUNDRUM

Samuel Cary Evans, onetime California state senator and mayor of Riverside, compiled a now-missing list of 35 or more proposed uses for cogged stones (Langenwaller and Brock 1984:77)! Onetime WPA archaeologist and relic collector Herman Strandt (1965:23), noting the varied forms, suggested several utilitarian

possibilities: (1) to manufacture rope, (2) to manufacture fish line, (3) to crush nuts and seeds, and (4) to provide lighting as lamps "with talc and wick." Other proposals include employment as gears for stone machines, musical instruments, boundary markers, fishline bobbins, cordage bobbins, net sinkers, calendrical mnemonics, weapons, and equipment for play behavior (Apodaca 2001; Archaeological Survey Association of Southern California [ASA] 1976; Barter 1983:31; Dixon 1975; Eberhart 1961:369; Moriarty and Broms 1971; Smith 1950). Other speculations include tools for arrow manufacture, milling equipment, and sling stones (*Long Beach Press Telegram*, 24 September 1930). The odd shape of one cogged stone inspired the suggestion of a combined utilitarian and ceremonial function: incense burner (Desautels 1968:67).

Figure 1: Location of relevant sites.



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Cogged stones are generally regarded as nonutilitarian and probably ideotechnic artifacts (Anonymous 1937b; Ashby and Winterbourne 1966; Chartkoff and Chartkoff 1984:108, 138; Desautels 1968; Dixon 1968:57; Eberhart 1961:361; Herring 1968:11; Moratto 1984:150; Smith 1950; Treganza and Bierman 1958; Wallace et al. 1956). One suggestion is that they served as symbols of wealth and power (ASA 1976). Dixon (1968:57) also offered the hypothesis that they were ritual paraphernalia of a religion having its center in the lower Santa Ana River drainage.

Suggestions of ceremonial and/or symbolic use rest on observations that either argue against utilitarian purpose or indicate ritual behavior. Such observations include the following: (1) lack of patterned use-wear; (2) manufacture of some specimens from soft lithic materials presumed unsuitable for many utilitarian purposes (Koerper and Mason 1998); (3) great effort required to produce the majority of specimens, versus economic behavior that is not cost-effective with regard to either archaic-level extraction or maintenance activities; (4) associations with mortuary remains and with other kinds of artifacts also considered to be magico-religious items; and (5) patterned groupings of cogged stones (e.g., Anonymous 1937a, 1937b, 1938; Dixon 1968:63-65; Eberhart 1961:368; Koerper et al. 1996a; Strandt 1965:24; Winterbourne 1968).

Cogged stones most probably originated in Orange County (Eberhart 1961:361) where virtually all seem to have been manufactured. Their distribution is highly concentrated around the area of the lower Santa Ana River drainage, which shifted through time, with the majority of provenienced specimens attributed to two sites near the coast, ORA-58 in Costa Mesa and ORA-83 in Huntington Beach (Figure 1) (Dixon 1968; Eberhart 1961; Herring 1968; Koerper et al. 1996a; McKinney 1968). Continuous occurrence of these artifacts along the coast proceeds roughly from southern Ventura County into San Diego County. Inland, cogged stones are reported from the southern side of the San Gabriel Mountains, barely into the southwestern corner of San Bernardino County, and penetrating the westernmost fifth of Riverside County (Eberhart 1961; McKinney 1968). Outlier finds include one specimen each from Fossil Falls, just north of Little Lake, Inyo County, and from Darwin, also in Inyo County (Eberhart 1961:365; Herring 1968:12; McKinney 1968:40). Helen Smith reportedly retrieved one near Chandler, Arizona (McKinney 1968:45). Herman Strandt (1965:23) reported that O. T. Littleton exhumed a cogged stone near Goleta in Santa Barbara County, but there are reasons to be skeptical of any provenience offered by Littleton (see Koerper and Chace 1995; Lee 1993). Parenthetically, a possible exception to local manufacture is the lone cogged stone find from Fossil Falls (see Herring 1968:12).

### PERIOD OF MANUFACTURE

A cogged stone recovered from ORA-1432 during data recovery excavations for the San Joaquin Hills Transportation Corridor Project is attributed to the eighth millennium B.P. (Koerper and Mason 1998; Mason 1997). One AMS assay (Beta-87388) from a charcoal sample obtained from a rock feature helps to date the artifact to around 6780 ±

50 B.P. (uncorrected). The conventional date is 6750 ± 50 B.P., and the calibrated age is 7546 cal B.P. with one-sigma range of 7607 to 7529 cal B.P. (Mason 1997:Table 4.3). An eccentric crescent, which has a similar date range (Koerper et al. 1996b), was found during the monitoring of grading near the location of the cogged stone find.

Chronometric, stratigraphic, and other data from ORA-83 indicate the floruit of cogged stone manufacture occurred sometime within the seventh through eighth millennia B.P. (Desautels, personal communication 2005). Culturally this falls to the earlier part of the Milling Stone period. We hypothesize that specimens recovered from post-early Holocene contexts are heirloom pieces that have been scavenged and recycled. They are generally also found in Milling Stone deposits.

### THE PROBLEM

Two initial approaches for decoding cogged stone symbology come to mind. One approach assumes that the artifact, in toto or in part, possesses a recognizable morphological signature(s) for what is being represented, thereby providing an opening to probe deeper levels of symbolic meanings. The other approach searches for patterns in caches containing cogged stones.

The first strategy is most recently illustrated in a study that interprets cogged stones as mimics of horizontal sections of cacti (Apodaca 2001). Apodaca's work (2001) drew upon ethnographically documented uses of cactus slices in Seri folk culture and notes on the Seri's symbolic portrayals of cactus. Apodaca (2001:215) even proposed a new taxon label, "cactus stone," to replace "cogged stone."

The late Armand Labbé interpreted the cogged stone shapes as possible representations of a variety of sea life, most notably sea anemones and sea stars (aka starfish) (personal communication 1989 to Koerper). Indeed two kinds of cogged stones are known as the Sea Star type and the Fish Vertebra type (see Underbrink and Koerper 2006).

Further, there has been general speculation, as yet unpublished, that cogged stones may have been fashioned in the likeness of celestial bodies, particularly stars, and perhaps the sun of our own solar system. There is some additional conjecture that if it is the sun that was represented, cogged stones might have been employed in solstice ceremonies.

We are cautious but not dismissive of interpretations that embrace cactus, sea creatures, or celestial imagery. Most probably, cogged stone artisans drew their inspiration from objects in nature, but apparently the medium was so conventionalized as to confound efforts to definitively identify any cogged stone referent, much less deeper levels of symbolism. Accordingly, we take up an alternative strategy to search out meanings, a strategy whose focus involves recognizing patterns based on associations in caches, whether those associations occur solely with other cogged stones or involve connections between cogged stones and other categories of magico-religious objects.

Specifically our strategy for lifting “thought prints” from cogged stones seeks patterned associations occurring within and between caches containing these artifacts, a task which requires identifying “matched pairs” of cogged stones within single caches. A “matched pair” is defined as two cogged stones displaying identical counts of cogs. We hypothesize that any observed phenomena of matched pairs would not have been the outcome of a random process of selection.

Caches were sought. Five caches were found from three sites, two with one matched pair and three with two matched pairs; however only three caches from two sites were available for use in this study. Two of these caches are from ORA-950, a site in Lake Forest in south Orange County, and one was unearthed at the Rancho Los Cerritos Adobe (LAN-696), a site in Long Beach in south Los Angeles County (Figure 1).

## THE CACHES

### ORA-950 Caches

ORA-950 Cache 1 contained five round artifacts including four Land-and-Groove cogged stones, all vesicular, and a scoria discoidal (Figure 2) and a lozenge-shaped glaucophane schist object (Figure 3). Two cogged stones have 12 cogs each. One additional specimen exhibits 11 cogs and another almost certainly had an identical number before it suffered edge damage. A qualitative estimate of 11 is not a difficult call since one can extrapolate from the spacing of the five extant cogs against indications that production of the piece followed a template of balanced symmetry. A quantitative approach applied an arc measurement encompassing the five cogs set against a calculation of circumference based on measurement of diameter. These procedures provided corroboration for a count of 11. To avoid bias, estimates were carried out before any other cogged stone was subject to a count of its cogs. Thus, with the four cogged stones there were two sets of matched pairs, an outcome unlikely to be the result of pure chance.

Cache 2 contains six cogged stones, five made of vesicular materials (Figure 4). They are equally divided in number between Land-and-Groove and Beveled types (see Underbrink and Koerper 2006). The Beveled type has been called both “jelly mold” and “summer squash.” There is only one pairing involving equal numbers of cogs: a Land-and-Groove type with eight cogs, and an eight-cog Beveled artifact.

At this point another hypothesis, complementary rather than competing, suggests itself. In the ancient ritual of cogged stone aggregation and subsequent interment, could another kind of pairing in the ancient mind-set be Beveled with Land-and-Groove? In Cache 2 we have seen that the pairing based on cog numbers involved both shapes. Now add all of this to the improbability of the ORA-950 Cache 2 having three Beveled specimens and three Land-and-Grooves. We offer the very conservative estimate that for every Beveled type manufactured, there were probably at least 10 Land-and-Groove examples.

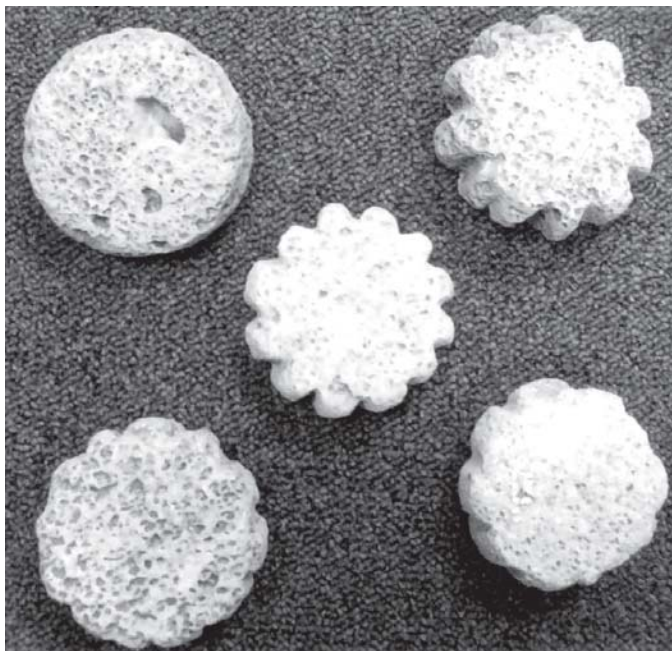
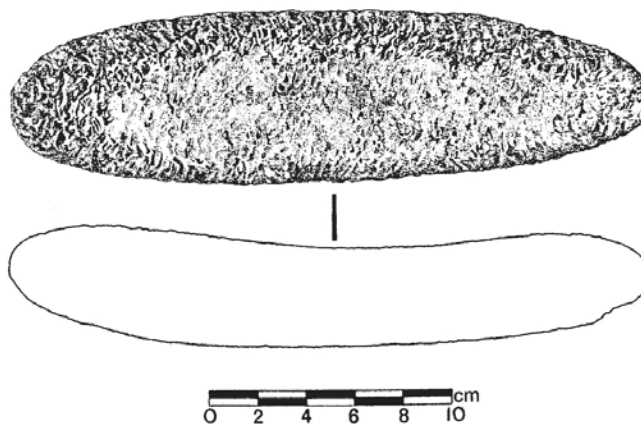


Figure 2: CA-ORA-950 Cache 1 cogged stones and discoidal. Discoidal top left is 9.2 cm in diameter.

### The Rancho Los Cerritos Cache

On September 22, 1930, during restoration work at the Rancho Los Cerritos Adobe in Long Beach (Figure 1), a laborer excavating a ditch for C. T. McGrew and Sons, plumbing contractors, discovered four discoidals and seven cogged stones stacked one atop the other in a graduated progression of decreasing artifact diameter from bottom to top (*Long Beach Press Telegram*, 24 September 1930). Nine of the 11 cache artifacts are retained in the collections of the La Casa de Rancho Los Cerritos Museum. Two cogged stone specimens were held out by the Bixby family and never returned to the collection. The five remaining cogged stones are made of vesicular stone, and all are Land-and-Groove style. A photograph of the cache (Figure 5) taken by Llewellyn Bixby on

Figure 3: CA-ORA-950 Cache 1 glaucophane schist object. Top and side views.



the day of its discovery reveals that the now-missing artifacts were also fashioned of vesicular basalt into Land-and-Groove shapes.

Two of the five remaining cogged stones have 14 cogs. Two exhibit 17 cogs. One of the missing cogged stones was traced, the record of which resides in the archives of the Rancho Los Cerritos Adobe. Its cog count is nine.

## STATISTICAL ANALYSIS

### The Cogged Stone Study Sample

A sample of 259 cogged stones is known for which the number of cogs has been counted. The larger part of this sample was amassed by Underbrink (2002) and the remainder by the senior author. The number of cogs varies from one to 20. A histogram of the counts follows a roughly bell-shaped curve (Figure 6). For manufactured objects this is itself a rather remarkable fact. Why this would be the case is something that deserves further thought. The mean and median are virtually the same as the mid-point of the range (Table 1). This is indicative of fairly symmetric data.

Although this set of 259 stones is not the universe of all created cogged stones, we probably can say with some confidence that it represents a large sample of that universe. Although it is what statisticians call a "convenience sample," there is no reason to believe that it deviates substantially in distribution from the universe of all cogged stones.

### The Sample from the Caches

In the three caches considered, and in the same order as above, there are respectively: (1) four cogged stones including two matched pairs; (2) six cogged stones including one matched pair; and (3) six cogged stones including two matched pairs. We investigate the probability of the number of matched pairs in a cache of certain given size and whether the number of matched pairs is likely to have occurred purely by chance. This is similar to determining the probability of having a pair in a poker hand. However, in our case the probability of a

*Figure 5: Rancho Los Cerritos Adobe cache. Photograph Llewellyn Bixby, September 22, 1930. Discoidal at center bottom is 14.8 cm in diameter*



*Figure 4: CA-ORA-950 Cache 2 cogged stones. Specimen on right is 7.8 cm in diameter*

stone having a certain number of cogs is not equally likely, whereas in the case of poker a given card is equally likely as any other card. Thus in our case, computing the probability is not simply a matter of counting cases.

The underlying probability distribution is bivariate with distribution  $F(X,Y)$ , with  $X$  the number of stones per cache and  $Y$  the number of pairs per cache. This assumes that the probability of the number of cogs per artifact is fixed by the original distribution, as the distribution would be trivariate if we considered the 259 cogged stones as a sample of an unknown distribution. The bivariate distribution is quite complex given the unequal probabilities of the number of cogs per stone. Rather than compute probabilities directly from a theoretical distribution, we use a rather simple procedure that is computationally intensive.

Using a random number generator, 500 theoretical samples of six were generated from uniformly distributed random numbers from 0 to 259. Noting that there were three stones with one cog, any random number from 0 to 2 was recoded with a one. Since there were four stones with two cogs, any random number from 3 to 7 was recoded with a two. The result is 500 samples of size six consisting of cogs numbering from one to 20. Each such number will approximately occur in direct proportion to the number of times it occurs in the cogged stone sample. We similarly generated probabilities for the number of pairs for samples of sizes of four and five, and replicated the computations.

Taking those results, the number cogs in each sample of four, five, and six was searched for matching numbers of cogs, and the probability

Mean	10.004
Median	10.000
Mode	11.000
Standard Deviation	3.809
Sample Variance	14.508
Range	19.000
Minimum	1
Maximum	20
Count	259

Table 1: Summary Statistics for 259 cogged stones with counted cogs

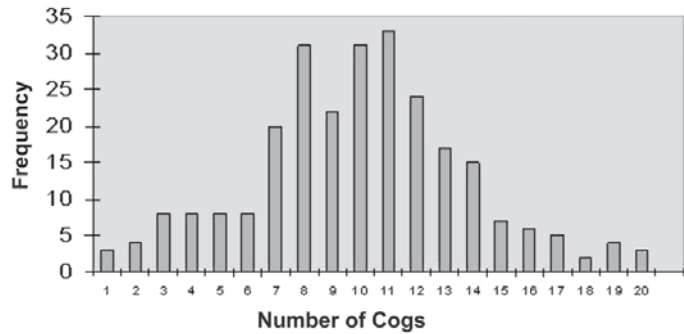


Figure 6: Histogram of cogged stone population by number of cogs.

was computed (Table 2). For example, a single pair would be one match, two pairs would be two matches, and a triplet would be three matches. In a sample of four, the average probability of one or more matches was .441 and of two or more matches was .045. In a sample of five, the average probability of one or more matches was .604 and of two or more matches was .113. In a sample of six, the average probability of one or more matches was .748 and of two or more matches was .282.

Using these probabilities, the approximate probabilities of the number of matched pairs in the three caches occurring purely by chance can be computed. The probability of four cogged stones with two matched pairs as in ORA-950 Cache 1 is .043. The probability of six cogged stones with one matched pair as in ORA-950 Cache 2 is .707. The probability of six cogged stones with two matched pairs as at Rancho Los Cerritos Adobe is .236.

Again making the assumption that each of the caches is stochastically independent, multiplying these probabilities can determine the approximate probability that all three caches would have the given number of pairs (or more) purely by chance. This probability is very small, seven in 1,000, and shows that it is highly unlikely that the number and distribution of pairs within the caches is a result of chance events.

**Discussion**

Five matched pairs of cogged stones are identified for three cogged stone caches discovered at two sites: ORA-950 in Lake Forest, Orange County, and Rancho Los Cerritos in Long Beach, Los Angeles County (Figure 1). It is improbable that random inputs alone could account for the phenomena of matched pairs at each site. When the three caches are considered in aggregate, the outcome probability, under an assumption of pure chance, calculates to .007. Thus a selective process targeted some artifacts by cog count, bringing together matched pairs, to significantly fashion the character of the caches. The several observations and their inferential treatment suggest a regionally shared iconography embracing dualistic symbology.

Our reasons for believing this to be so course through considerations both general and specific. The most obvious duality in nature turns on male and female elements, and for

those people especially intimate with nature on a day-to-day basis the dualism often receives expression in sex-based imagery, either in world view or certain material manifestations of world view (see Gravel 1995:57). There is ample testimony for such in coastal southern California ethnographic and archaeological records.

There are other Milling Stone period examples of same-genre artifacts that were ritually buried, it would seem, with intent to create pairings. For instance, such events are easily inferred from a trio of spectacular caches unearthed at ORA-64 in Newport Beach (Macko et al. 2005). One consisted of two nearly identically crafted bowling-ball sized stone spheres, or “ball stones,” weighing 11.4 kg and 11.8 kg. In another sacred ceremony, two very large stemmed-base spear points had been placed together and oriented in the same general direction. The third ritual cache contained four objects, including two more very large bifaces next to each other but pointing in opposite directions. Additionally, it contained two objects of different genre but, we suspect, of complementary symbolic content: a plummet-like charmstone and a perforated globular stone of the type discussed in Koerper and Singer (1988). The communications here had likely connected with, respectively, male and female principles.

The most complete ethnographic references bearing on duality as a leitmotif in coastal Shoshonean worldview are found in Luiseño ethnographic accounts. Male-female dualism is extensive, occurring in

Table 2: Probability of matches in samples of three sizes.

	<u>1 or more matches</u>	<u>2 or more matches</u>
<i>Samples of size 6</i>		
Run 1	.752	.288
Run 2	.738	.270
Run 3	.754	.288
Average	.748	.282
<i>Samples of size 5</i>		
Run 1	.602	.112
Run 2	.602	.122
Run 3	.608	.106
Average	.604	.113
<i>Samples of size 4</i>		
Run 1	.444	.044
Run 2	.428	.056
Run 3	.450	.036
Average	.441	.045

the creation myth, the origin myth of the *no:tuš* (concerning mourning ceremonies), and elsewhere (Applegate 1979). Indeed Applegate (1979) demonstrated that an extensive system of such polar opposites uniting under higher principles lay at the very heart of Luiseño myth, ritual and Weltanschauung (see Levi 1980). Significantly, he saw the fundamental dualism of the Luiseño culture as common to much of southern California (Applegate 1979:71).

Koerper and Labbé (1987, 1989) drew upon Applegate's cogent analysis to support their hypothesis that late Holocene birdstones (aka pelican stones and hookstones) communicated this very same dualism and unity. Recognizing the phallic and vulvar imagery in the more graphically rendered birdstones, they referred to the type as a kind of dimorphic sexual symbol and noted that cross-culturally there were countless instances of dyads that are reasonably viewed as "interlocking male and female forces denoting the interplay of complementary dualities and invariably connoting fertility and dynamism" (Koerper and Labbé 1987:116; cf. Labbé 1980; Reichel-Dolmatoff 1975; Roe 1982). In another place, Koerper and Labbé (1989:48) offer thoughts bearing some similar content but with specific reference to the birdstone genre, to wit, "the iconographic reference is not a direct reference to genitalia per se, but to genitalia as metaphor representing a process leading to fertility, fecundity or related themes."

Birdstones are an exception in communications of dualism in coastal southern California in the sense that the vast majority of such symbology when relying on tangibles does not occur wrapped in a single artifact. Rather, the dualistic theme is more likely to be conveyed when a combination of artifacts carrying sex-based symbolism, one or more male-connected and the other(s) female, form a complementary package, particularly for a ritual setting. An obvious example is the pestle-mortar/bowl combination (see Koerper 2001). Sexual double entendre should be particularly obvious for the Hellman Ranch bowl and pestle (Koerper 2006). Another quick example is offered by the magico-religious cache found by WPA archaeologists at ORA-104 in Corona del Mar. It contained a large birdstone, two "spikes," which are generally recognized as phallic (see Lee 1981:50), and a ceremonial "donut stone" (Winterbourne 1967:21). Koerper (2005) describes the processes of sexualization and sacralization to explain that donut stones are probably sex-based (female) ceremonial objects.

These examples and many more (see Koerper 2005) demonstrate that sex-based symbology was extensive in regional iconography. One recently recognized genre most probably denoting the female principle may prove particularly instructive with regard to our attempts to seek meanings for cogged stones. That genre is a varied grouping of artifacts whose overall outline is generally lozenge-shaped to ovate. Of those sculpted of stone, many display a lenticular cross section as opposed to a round cross section. Thus the faces are normally convex, yet there are some that might be characterized as tablets with relatively flat lower and upper faces. The edges of the lenticular cross section are curvilinear, not sharply angled. When there is a longitudinally running design factor (usually on just one face), it is sometimes a thin line of asphaltum, but sometimes a broader swath of the adhesive has been laid down to glue small shell beads to the artifact. The longitudinal element might also be closely spaced parallel incised lines. At the

interpretive level, the commonality is an artistic attempt to convey pudendum imagery. Rarely, a natural water-worn stone manuport will evidence attributes suggestive of a vulvar look.

And why is any of this relevant here? The glaucophane schist oddity in Cache 1 at ORA-950 (Figure 3) in plan view is a narrow, lozenge-shaped artifact. In places it is lenticular in cross section with edges curved and rounded/blunted ends. It was crafted from a sherd from a broken metate. Despite its large size (length = 264.1 mm, width = 68.9 mm, thickness = 45.1 mm; weight = 1334 g), it could not have served well as a percussive tool, such as a pestle, since forces at either end would have shattered the artifact along the planes of the natural bedding of the lithic material. Further, the curvature of the object as seen in side view would have served as impediment to any practical application involving forces impacting the ends. Further, an incongruity attaches to a mere tool being placed with a cache of magico-religious objects. While superficially the object is somewhat phallic, under the criteria set out above, it is a close approximation of the newly proposed genre of vulvar motifs, although no visible longitudinal design element graces either face. Recall that two sets of matched pairings accounted for all of the cogged stones in the cache. In this ritual grouping, the dualistic thematic is writ large, and thus a sex-based symbology attaching to the glaucophane schist oddity would seem consistent. This seems to be another case in which there was an overarching concern with fertility/fecundity, nature's bounty, or related matters.

## SUMMARY

Five matched pairs of cogged stones have been described for three ritual caches from two Milling Stone period sites. The cumulative probability of the samples of cogged stones having five or more matched pairs in terms of number of cogs is .007 and is thus demonstratively nonrandom.

A selective process operated to communicate, we believe, a dualistic symbology rooted in the ideal of the complementary male and female principles. This may have been a ritual requirement for achieving some amount of control in the realm of fertility, fecundity, and nature's bounty. Inspiration for these hypotheses drew not only from a broad cross-cultural record but from regional ethnographic and archaeological data sets.

There remains the question of what object(s), natural or cultural, might have offered the visual model(s) for sculpting the cogged stone class of artifacts, assuming the designs were not purely abstractions. Would the model(s) have provided any sex-based referent, directly or indirectly, as would seem reasonable had there been a fertility/fecundity, increase, or related thematic? Such questions contribute grist in the continuing investigations of a most fascinating kind of artifact.

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